Thoraco-Abdominal and Abdominal Aortic Aneurysms Involving Renal, Superior Mesenteric, and Celiac Arteries

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The treatment of 23 consecutive patients with thoraco-abdominal aortic aneurysms and abdominal aortic aneurysms involving the renal, superior mesenteric, and celiac arteries is analyzed. Emphasis is placed on surgical technique which was dependent upon the location and extent of aneurysm, the nature of the aneurysm, and the period of treatment. The aneurysm was syphilitic in origin and sacciform in two patients involving the posterior circumference opposite renal, superior mesenteric, and celiac arteries. In these cases, the aneurysmal sac was simply excised and the defect closed with a Dacron patch through abdominal incision. The aneurysm was arteriosclerotic and fusiform in 16 patients involving the major visceral vessels. Early in the experience, treatment consisted of inserting bypass graft and then reattachment of involved branches to side-arm tube grafts arising from the bypass. In the majority of cases, treatment consisted of insertion of the graft inside the aneurysm and reattachment of visceral branch origins directly to an opening in the graft wall. Thoraco-abdominal incisions were employed when both the thoracic and abdominal aortic segments were involved. Operation was confined to the abdomen when only the abdominal aortic segment was involved. The aneurysm involved only the renal arteries in 5 patients treated by variations of the above procedures. Of the 23 patients treated, 22 survived and did well for periods up to 13 years, indicating the feasibility of safe therapy employing simpler techniques than generally advocated.

ANEURYSMAL DISEASE OF THE AORTA rarely involves the segment of abdominal aorta from which the renal, superior mesenteric, and celiac axis arise. When these vessels are involved, the aneurysm may be thoraco-abdominal, involving segments of varying length of the descending thoracic aorta and abdominal aorta, or it may be truly abdominal in location, being confined to the aortic segment below the diaphragm involving one or more of these arteries. These aneurysms pose the most difficult challenge to treatment owing to the difficulties of exposure, the need to minimize the period of visceral organ ischemia required for operation, the technical problem of aortic and arterial reconstruction needed for permanent restoration of circulation, and control of hemorrhage both during and after operation.

Apparently, due to the relative rarity of these lesions, there are few reports on their successful treatment; however, there is general agreement as to their serious nature. The only report (42 cases) other than a few case reports is the pioneering experience of DeBakey and associates.[4] The mortality in this series was 26% and was related to age and associated disease inasmuch as younger patients without associated disease survived in about 90% of cases. This mortality, however, is higher than that for treatment of simple abdominal and thoracic aortic aneurysms in a similar patient population, indicating that the magnitude of surgical treatment is the major factor in mortality. During the past 13 years, the author has treated 23 patients of this type, utilizing techniques in the more recent cases which reduce the extent of operation and have been associated with a low mortality (1 death). Accordingly, this report is concerned with certain changes in pathologic concepts, the needs for reconstruction, requirements for visceral organ support during operation, surgical techniques, and results of therapy.

Clinical Material

There were 19 males and 4 females in the series. The ages ranged from 36 to 83 years with 1 in the fourth, 5 in the fifth, 3 in the sixth, 11 in the seventh, 2 in the

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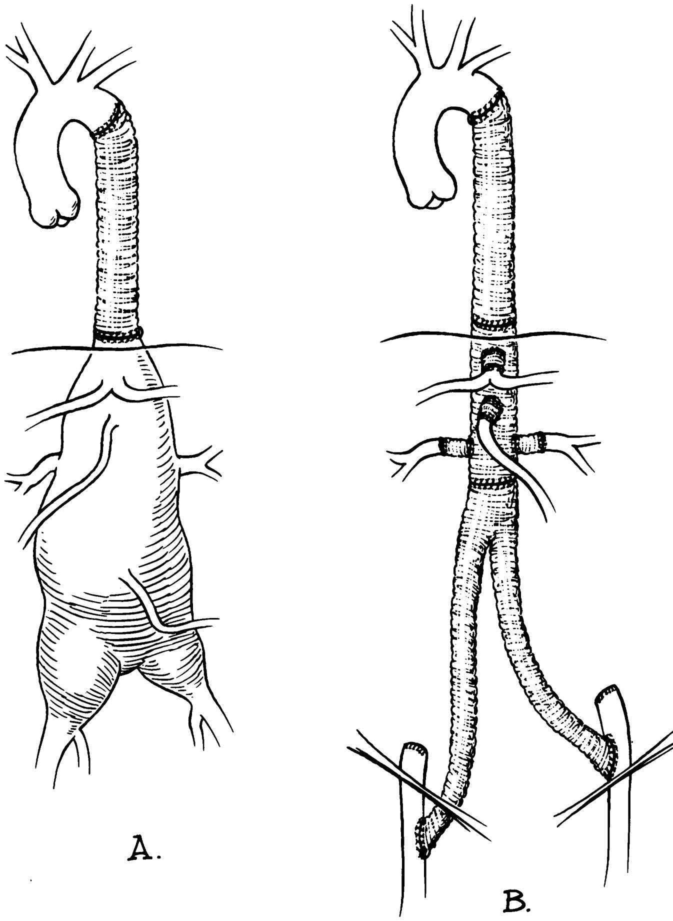


FIG. 1. Removal and graft replacement thoraco-abdominal aortic aneurysm involving distal thoracic and abdominal aorta and iliac arteries three years after removal of proximal two-thirds of the descending thoracic aorta using Type I operation.

eighth, and 1 in the ninth decades of life. The etiology of aneurysm was trauma in 1, syphilis in 2, dissecting in 3, and degenerative or atherosclerotic in 17 patients. The aneurysm involved both the thoracic and abdominal aortic segments in 12 patients with almost the entire descending thoracic aorta and abdominal aorta in 6. The aneurysm was abdominal in location in 11 patients, involving only the renal arteries in 5 and involving renal, superior mesenteric, and celiac axis in 6 patients. All aneurysms were symptomatic with back, chest, or abdominal pain being the commonest complaints. Proximal segments of the descending thoracic aorta had been removed previously in 3 patients for aneurysm, and 2 patients had had infra-renal aortic replacement for ruptured aortic aneurysm. The presenting aneurysm had ruptured into adjacent structures in 4 patients and freely into the peritoneal cavity in 2 patients. Operation was performed to relieve pain, prevent rupture, or treat rupture in these cases.

Surgical Technique

The technique of operation varied with the location, nature, and extent of aneurysm and with the period of operation and is discussed accordingly.

Fusiform Aneurysm Involving Renal, Superior Mesenteric, and Celiac Axis

Early in the experience in treating aneurysms involving all the adbominal visceral arterial branches in 4 patients, the aortic graft (woven Dacron) with appropriately attached side-arm 8 mm knitted Dacron tubes for anastomosis to the involved arteries was inserted first as a semi-bypass graft through thoraco-abdominal exposure, delaying visceral arterial blood flow interruption as long as possible.[4] The grafts were inserted end-to-side or end-to-end distally to the iliac or femoral arteries first on one side. The aortic end of the graft was attached end-to-end to the transected proximal thoracic aorta above the aneurysm; and with blood flowing through the aortic graft into the leg and aneurysm (in most cases), the other distal or iliac limb or graft was attached and blood allowed to flow through it. The left renal artery was then attached to the appropriate side-arm graft, permitting flow to the left kidney. The aneurysm was then removed and right renal, superior mesenteric, and celiac axis were

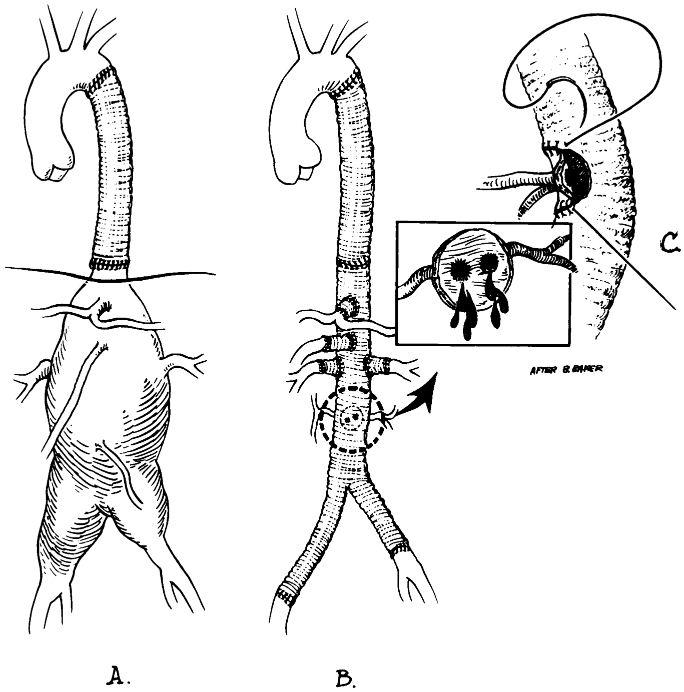


FIG. 2. Removal of thoraco-abdominal aneurysm involving distal thoracic and abdominal aorta and common iliac arteries six years after removal of proximal three-fourths of the descending thoracic aorta using Type I operation. A cuff of aorta from which two large lumbar arteries arose was preserved during resection and sutured to aortic graft to avoid spinal cord ischemia.

dissected from adjacent structures and attached in this order end-to-end to side-arm grafts, restoring circulation successively in these vessels (Figs. 1, 2). Operation by this technique is referred to as Type I operation.

Later in this series, operation in 12 patients either with thoraco-abdominal or abdominal aneurysm with involvement of renal, superior mesenteric, and celiac axis was simplified by employing a technique refered to as Type II operation.[1] The left posterio-lateral aspect of the aneurysm and normal segments above and below the aneurysm were exposed with very minimal dissection (Figs. 4c, 5d). Using electrocautery, the left posterior gutter peritoneum was incised and the retroperitoneum entered. The spleen, stomach, body and tail of pancreas, left colon, and kidney were reflected medially only enough to expose a small part of the posterior lateral circumference of the aneurysm. Clamps were placed above and below the aneurysm; and with aortic blood flow in the aneurysm arrested, the aneurysm was incised longitudinally at a level 3 centimeters behind the origin of the left renal artery (Fig. 3a). The cut edges of the aneurysmal wall were retracted with stay sutures and contained clot removed (Fig. 3b). Bleeding non-occluded intercostal and lumbar arterial orifices were either sutured or preserved for reattachment to aortic graft. The orifices of the renal, superior mesenteric, and celiac axis were identified and cleared of clot but not clamped because retrograde bleeding was minimal and prevented distal thrombosis. Atherosclerotic lesions partially or completely occluding these vessels were removed by endarterectomy. One end of an appropriately fitting woven Dacron tube was sutured from inside with continuous Dacron suture to the aorta above the aneurysm, carefully incorporating all layers of the proximal aorta in the suture (Fig. 3b). With the Dacron tube in appropriate downward tension, an elliptical segment of the anterior medial part of graft circumference was removed, leaving an opening large enough to suture around that part of aortic wall containing the origins of the right renal, superior mesenteric, and celiac axis. First the posterior edge of graft opening was sutured from inside of graft to aorta behind the origin of the vessels (Fig. 3b), and then the anterior edge was sutured to aorta outside the graft anterior to the origin of the vessels (Fig. 3c). Care was taken to place the suture line as close as pos-

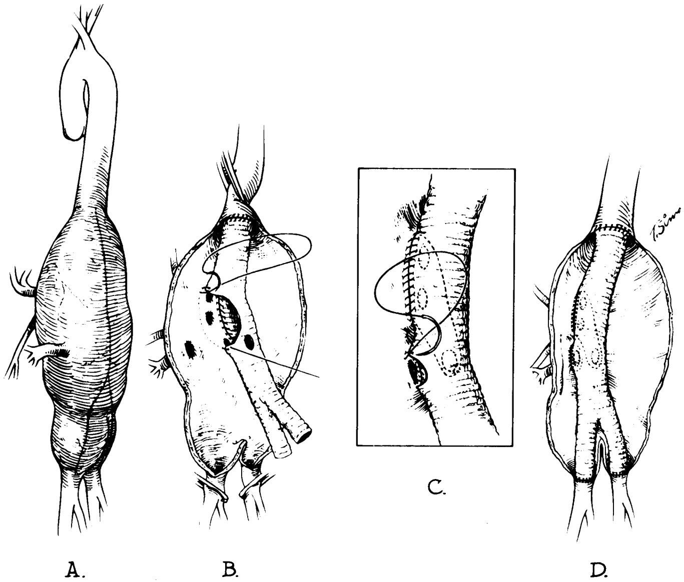


Fig. 3. Diagrams of case illustrating method of Type II operation in patient with aneurysm involving distal thoracic and abdominal aorta and common iliac arteries (a) including origins of all visceral branches. The aneurysm (a) is incised longitudinally behind the left renal artery and (b) the edges of the aneurysm are retracted to expose the origins of the branches of the abdominal aorta. The proximal end of aortic graft is first inserted; then, an oval opening is made in the graft and one edge of the graft opening is sutured to aneurysm wall behind the origin of celiac, superior mesenteric, and right renal arteries. The other edge of graft opening (c) is sutured anteriorally around the origin of these vessels; and after an appropriate opening is made in the graft, the left renal artery orifice is attached directly to the graft. The iliac limbs of graft are attached (d), completing vascular reconstruction.

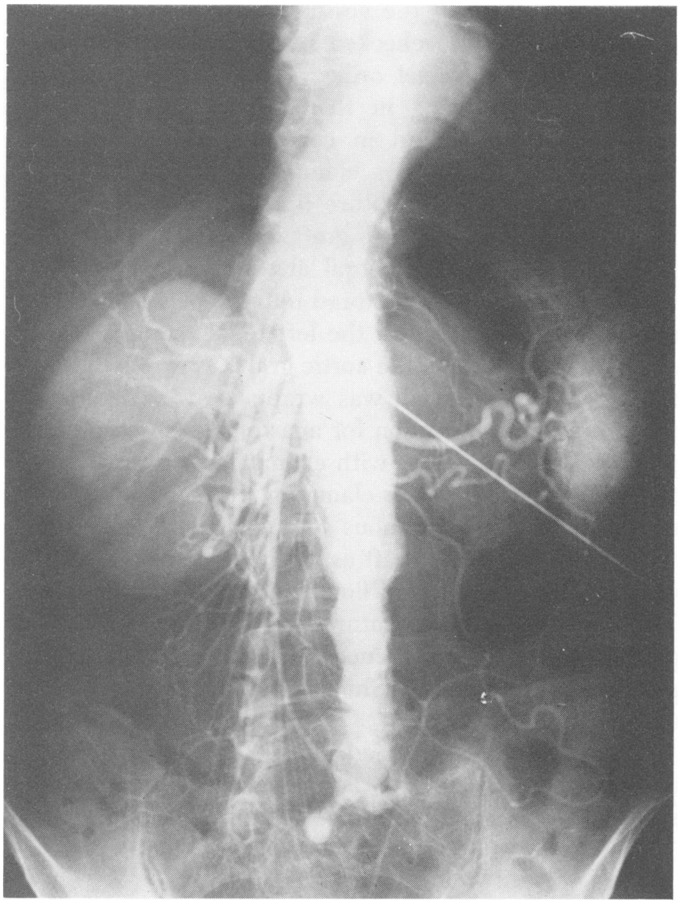


Fig. 4a. (See legend on next page.)

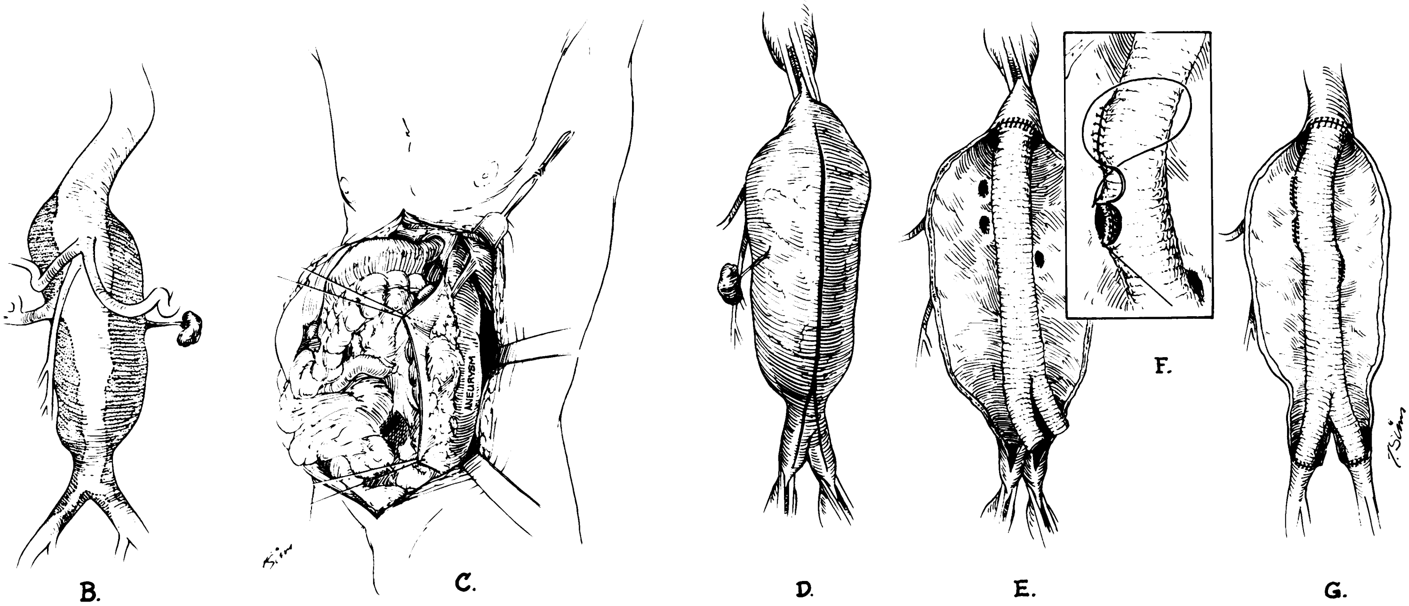
sible to the origin of the vessels without producing obstruction which was checked by intermittently placing a probe into the vessel orifices as the suture line was being made. Suturing in this manner left very little weakened aorta behind in contact with graft lumen. After flushing the graft, a clamp was placed across the graft just distal to this suture line and flow restored in these three vessels. Distal graft attachment was made to the aorta, iliac, or femoral arteries as extent of disease required and flow restored into the pelvis and lower extremities. The orifice of the left renal artery was then attached to the side of the aortic graft (Figs. 3c, d). First the involved aortic wall was wrapped over the graft to determine proper location for anastomosis. A segment of graft wall was excluded with clamps, either partially occluding or complete cross clamping, an elliptical segment removed, and by continuous suture, the left renal artery orifice was sutured to graft as just described. The clamps were removed and blood flow restored to all structures. The aneurysm wall was sutured around the graft and the peritoneal gutter reconstructed by continuous suture of peritoneum (Fig. 5m). Shunts and bypasses were not used in these operations.

Operation was performed through a long midline abdominal incision with the patient lying in the supine position, thus confining operation to the abdomen in those patients in whom the aneurysm did not extend above the diaphragm (Fig. 4c). When the aneurysm did extend above the diaphragm, a thoraco-abdominal incision was employed as in Type I operations by placing the patient in a rotated position so that the abdomen and pelvis were nearly in the supine position and the thorax nearly in a position of 45 degrees anterior rotation. In this position the appropriate inner space was entered and the incision extended into the abdomen across the costal arch into a long midline abdominal incision. Retroperitoneal and posterior mediastinal exposure was obtained as described above with the additional cutting of the diaphragm (Fig. 5d).

This technique in the two most recent cases has been modified only to the extent that the individual orifices of the renal, superior mesenteric, and celiac axis were sutured to individual circular openings made in the graft as described above for the left renal artery, thereby in effect excluding all of the weakened aortic wall (Figs. 4, 5). This technique is referred to as Type III operation.

Syphilitic Aneurysms

There were two aneurysms of syphilitic origin in this series of 23 cases (8.6%). Characteristically, the aneurysm in both instances was sacciform in nature and arose opposite the origin of the superior mesenteric and celiac



FIGS. 4a–g. Illustrations of Type III operation in patient with hypertension, intermittent claudication, and tender pulsatile upper abdominal mass. Aortogram (a) and diagram (b) show abdominal aortic aneurysm extending from just below diaphragm to above bifurcation involving all visceral vessels. The left renal artery is completely occluded and the left kidney is infarcted and shrunken. Both common iliac arteries are partially occluded. Exposure is obtained through a long midline abdominal incision and retraction of abdominal viscera to the right after incising the peritoneum along the left gutter (c). A longitudinal incision is made behind the origin of left renal artery (d) and the aneurysm edges are retracted and the origin of vessels exposed (e). After attaching the proximal end of aortic graft (e), appropriate openings are made in graft and origins of vessels except left renal artery are sutured directly to graft (insert f). The infarcted left kidney is removed. The iliac limbs of graft (g) are attached distally, completing arterial reconstruction.

axis involving only the posterior half of aortic circumference. Surgical treatment in both cases consisted of exposure through an abdominal incision as in a Type II or III operation (Fig. 4c). The aneurysm was excluded from aortic circulation by placement of clamps accross the aorta below the renal arteries and above the aneurysm in the region of the aortic diaphragmatic hiatus (Fig. 7c). The aneurysms were entered, clots removed, aneurysmal tissue trimmed from normal aorta, and aortic defect repaired by insertion of oval patch grafts made of knitted dacron fabric using continuous dacron sutures (Fig. 6).

Aneurysms Involving Only Renal Arteries

The aneurysm was fusiform in nature located in the distal abdominal aorta and involved the origin of one or both of the renal arteries in five patients (21%) in this series. In one patient aneurysmal disease extended out into both renal arteries to the origin of the primary branches, causing complete obstruction in one and partial obstruction in the other artery (Figs. 7a, c). This patient had severe hypertension, abdominal pain, and abdominal tenderness. Operation in this case was made through a long midline abdominal incision (Fig. 7b). The aneurysm was exposed by retracting small bowel and duodenum and incising the posterior peritoneum as is routinely done in patients with resection of infra-renal abdominal aortic aneurysms. The upper limits of aneurysm located just distal to origin of superior mesenteric artery was exposed by retracting the left renal vein inferiorally. The distal end of the left renal artery aneurysm was exposed as in operations for left renal artery bypass or endarterectomy for occlusive disease. To avoid superior mesenteric artery damage, the aorta was clamped proximally after being mobilized above the celiac axis in the region of the aortic hiatus of the diaphragm by splitting the right margin of the esophageal hiatus vertically and dissecting out the aorta with blunt dissection using the index finger to avoid perforation and tearing posterior branches (Fig. 7c). The iliac arteries were clamped and the aneurysm entered through a full-length longitudinal incision placed anteriorally. Clots were removed and a woven tubular graft was inserted inside the aneurysm as described above in the Type II operation (Fig. 7d). After blood flow was restored in the aorta, the left renal aneurysm was incised longitudinally; and one end of an 8 mm knitted Dacron graft was sutured to the distal renal artery and then the other end sutured to the aortic graft using partial occlusion clamps and continuous Dacron suture (Fig. 7e). The right kidney was found to be atrophic and was removed. The aneurysm wall and posterior peritoneum were then closed around the graft completing operation (Fig. 7f).

Procedures employed in the other cases were either

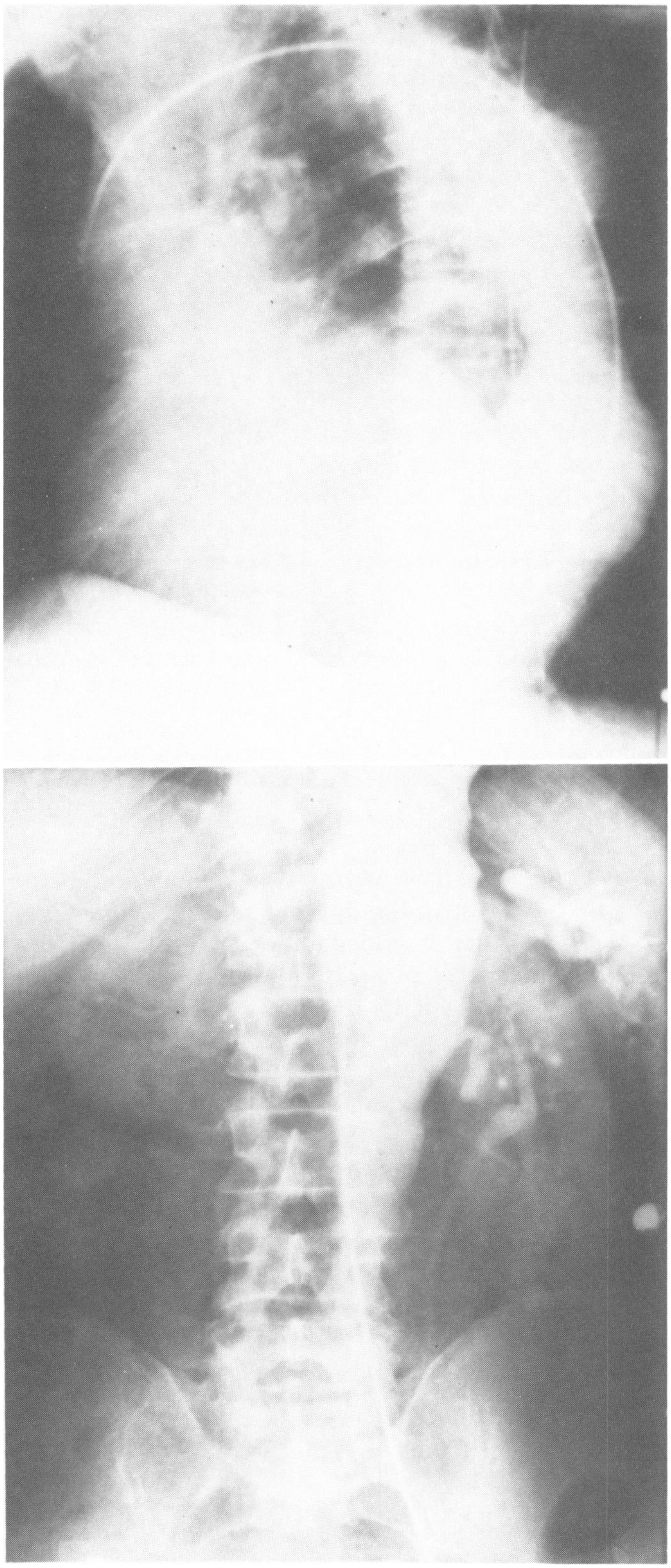


FIG. 5a. (See legend on next page.)

those depicted in Figs. 8, 9, variations of the case presented, or variations in cases in Figs. 8, 9. Regardless of technique of reconstruction, exposure and proximal and

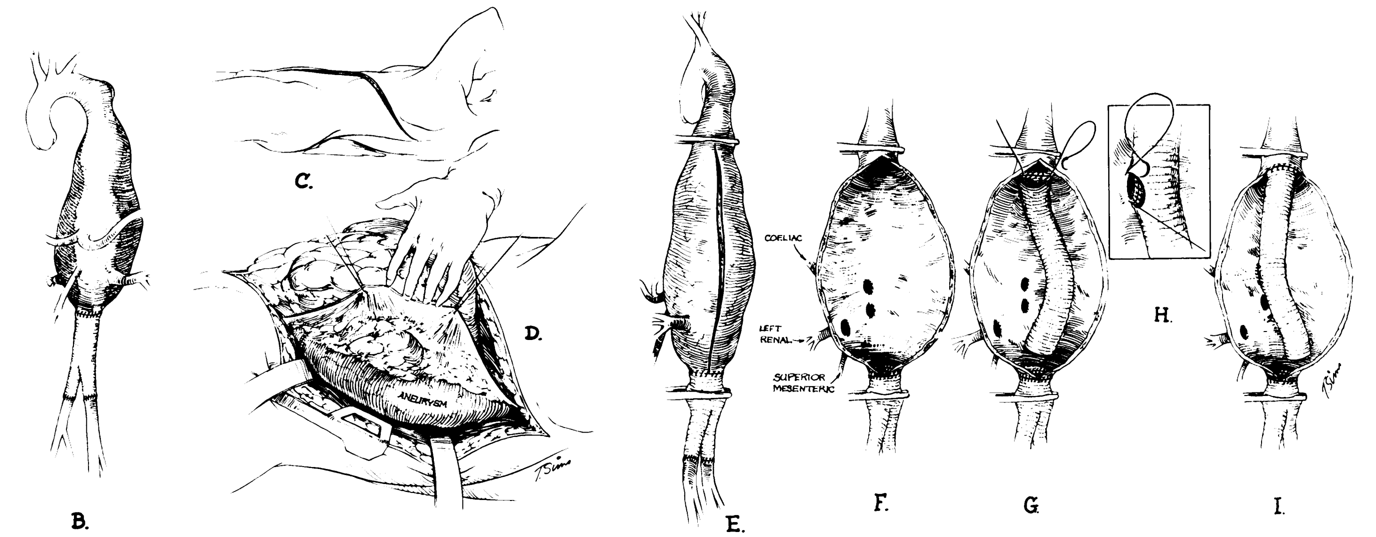


FIG. 5a–o. Illustration of the Type III operation in patient with ruptured thoraco-abdominal aneurysm who had had previous right nephrectomy for renal artery occlusion and infra-renal aortic replacement for ruptured abdominal aortic aneurysm. Aortogram (a) and diagram (b) made before operation showing extent of aneurysm and partial occlusion of left renal artery. The aneurysm is exposed retroperitoneally by thoraco-abdominal incision (c) and retracting abdominal viscera to the right (d). The aneurysm is incised longitudinally between clamps behind the left renal artery (e) and the edges of aneurysm retracted (f) exposing origin of visceral branches. The proximal aortic anastomosis (g) is made and then the origin of celiac axis is sutured directly to a circular opening made in the graft (h, i). Blood flow is restored into the celiac axis as the superior mesenteric artery is similarly attached (j). The left renal artery is then attached after endarterectomy (k) and reconstruction completed by suturing new graft to distal graft (l). Aneurysmal wall (m) is then sutured around the graft. Aortogram (n) made after operation showing graft in place with attached branches in posterior anterior projection. Aortogram (o) made after operation in lateral projection showing graft in place and attached visceral branches.

distal aortic blood flow control is the same as in the case presented. Reconstruction in the case depicted in Fig. 8 is identical to that described above in the Type III operation whereas that in Fig. 9 is related to that in both the Type II and Type III operation. The origin of renal artery is detached from the aneurysm by removing a button of aneurysm wall containing the renal artery orifice. This is attached to an oval opening of the dacron graft by continuous suture incorporating the entire patch leaving only renal artery orifice and lumen exposed to pressure of blood flow.

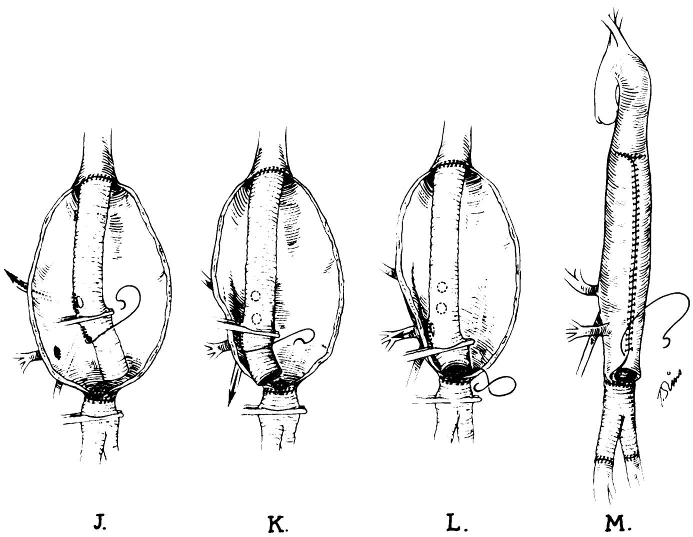


FIG. 5j–m.

Spinal Cord Ischemia

Permanent spinal cord ischemic damage manifested by lower extremity neurologic deficits is a real consideration in these cases evident by the fact that this complication occurred in one patient in this series. The proximal two-thirds of the descending thoracic aorta had been removed three years before admission for dissecting aortic aneurysm. Subsequently, the distal aorta and iliac arteries, damaged by dissection, became aneurysmal and were resected for pain using Type I operation (Fig. 1). Paraplegia in this case was considered to be due to the fact that cord blood supply had been permanently interrupted by ligation of all intercostal and lumbar arteries. Consequently, one or more of these vessels were reattached in the other patients in whom such extensive resections were performed (Fig. 2). Reattachment was accomplished either by suturing a button of aorta from which intercostal or lumbar arteries arose to the side of aortic graft or by interposing a very short segment of 8 mm knitted Dacron graft from aortic graft to posterior aortic wall surrounding the origin of a pair of intercostal or lumbar arteries.

The role of hypotension in the production of para-

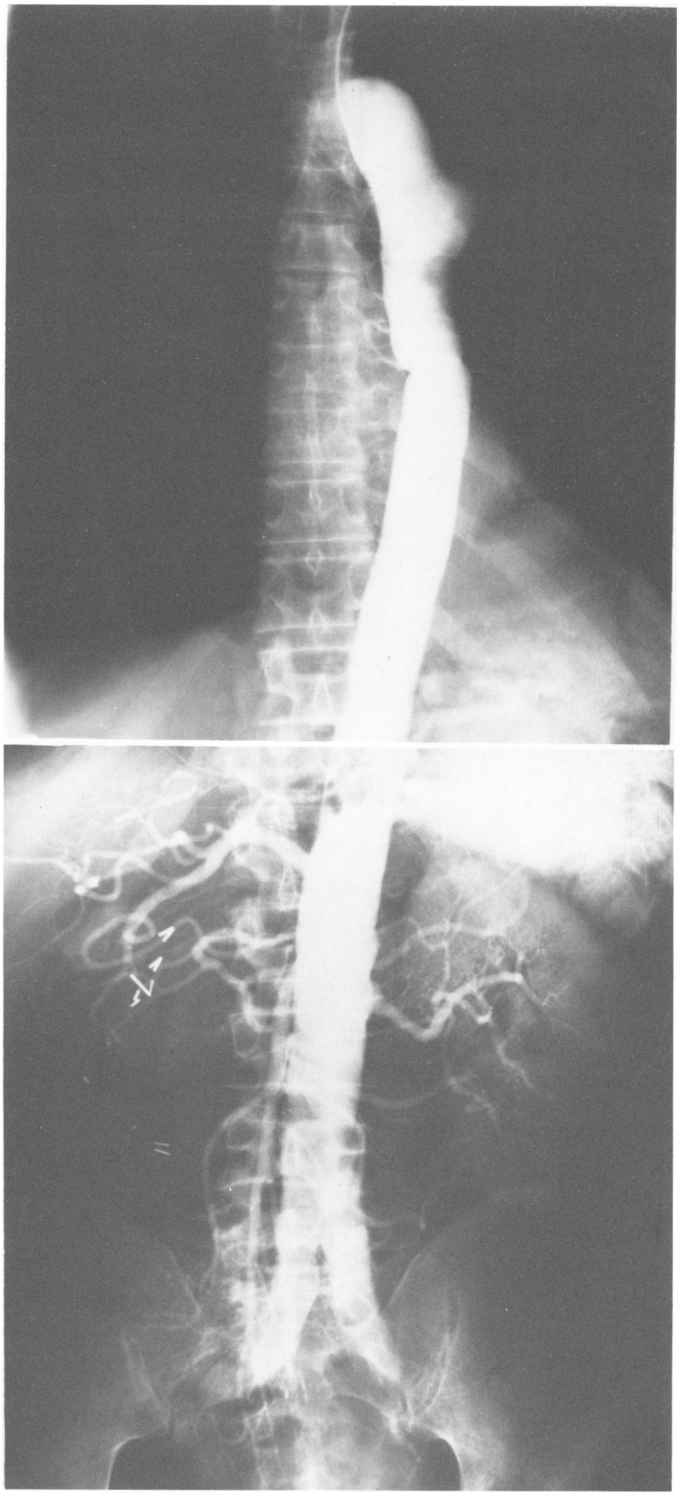


FIG. 5n.

plegia is extensively covered in previous publications and will not be elaborated here except to again emphasize the necessity of avoiding hypotension both during and after operation.[2,3] This problem is well illustrated by one patient in this series who recovered well from operation only to develop paraplegia during a period of hypo-

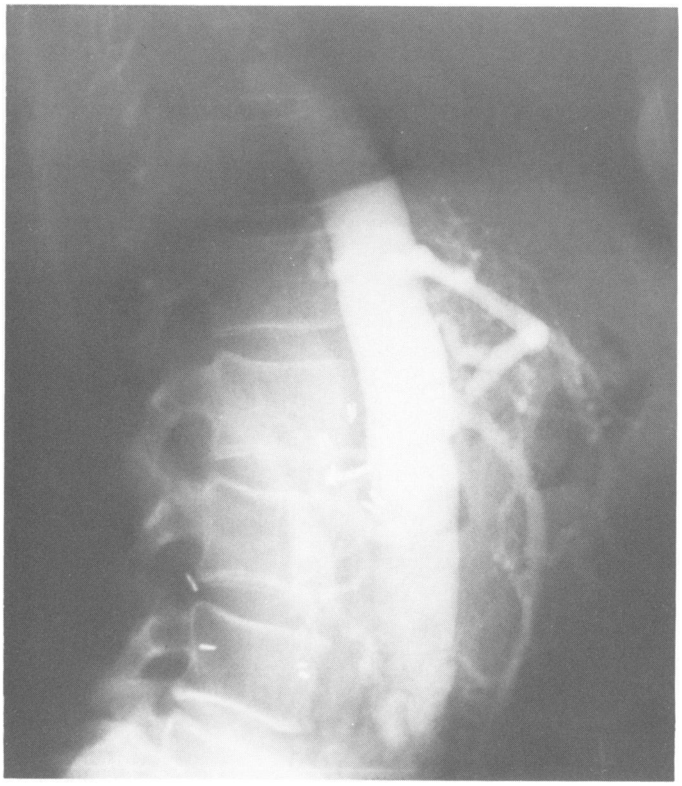


FIG. 5o.

tension. Fortunately, the hypotension from cardiac arrhythmia was immediately corrected and the neurologic deficit subsided in about 30 minutes.

Results

Among the 23 patients in this series, only one patient died and this was one of the four patients in whom the Type I operation was employed. Death in this case was

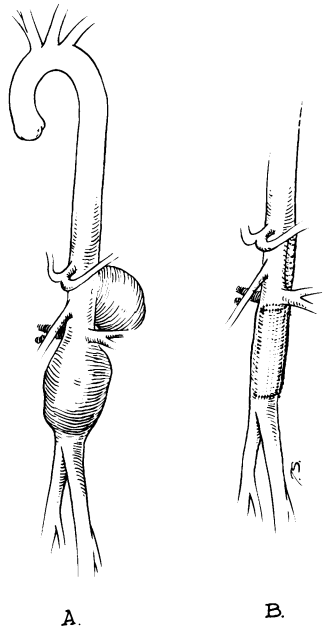
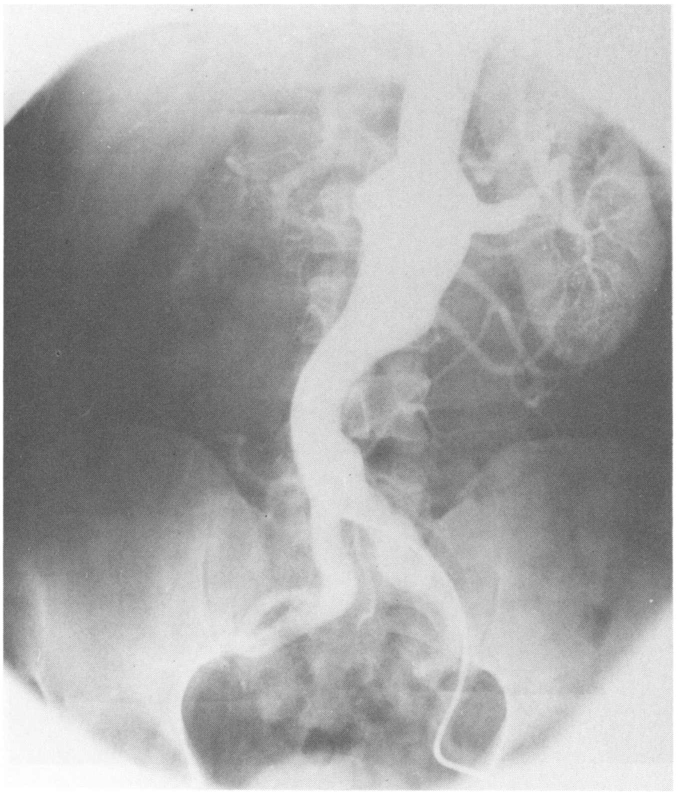


FIG. 6. Diagram of treatment in patient with fusiform aneurysm involving infra-renal aorta and sacciform aneurysm involving posterior circumference of aortic wall behind celiac and superior mesenteric arteries. The former was replaced with tubular graft and the latter with patch graft.



FIGS. 7a–f. Illustrations of patient with distal abdominal aortic aneurysm which involved both renal arteries causing complete obstruction on the right. Aortogram (a) and diagram (c) showing extent of disease. The aneurysm was exposed through long midline abdominal incision (b) and aorta clamped above celiac axis in hiatus of diaphragm. The iliac arteries were clamped and the aneurysm incised. The aortic graft was inserted inside the aneurysm (d–e) and then left renal artery reattached (e) using 8 mm. knitted dacron graft. Aortogram after operation (f) shows grafts in place and functioning.

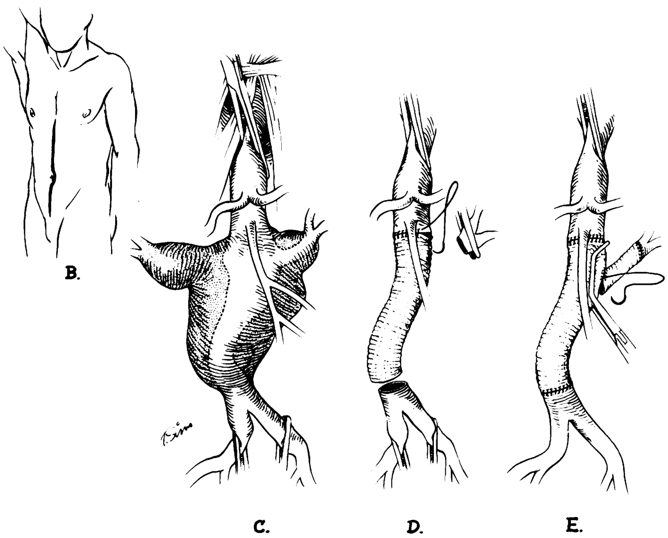


FIG. 7b–e.

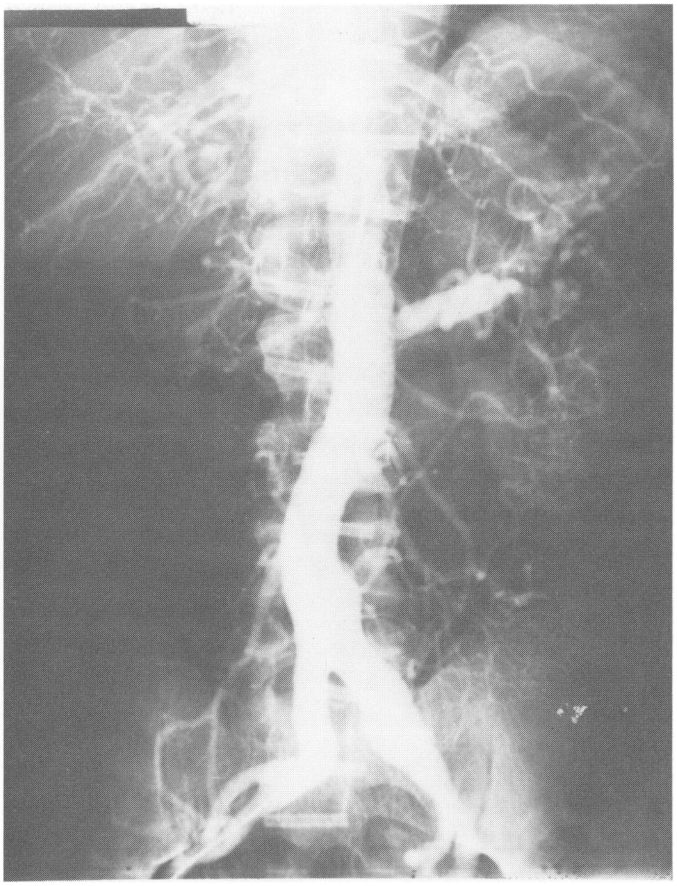


FIG. 7f.

due to multiple complications relating to surgical technique and the extent of operation required for its application. Of the 22 survivors, 16 are alive and doing well: 1 for 13 years, 4 from 5 to 8 years, 9 from 1 to 3 years, and 2 for more than 6 months. The cause of late death was ruptured false aneurysm in 2 patients after Type I operation, at 6 years in one and 13 years in the other; myocardial infarction in 2 patients, at 2 months in one and 1 year in the other; uremia from pyelonephritis and bilateral staghorn calculi in 1 patient at 2 years; and 1 from carcinoma of the lung at 3 years. One patient developed permanent weakness of the lower extremities following operation which persisted until his death 6 years later from massive hemoptysis (presumably from ruptured false aneurysm into bronchus). Paraplegia occurred transiently for about 30 minutes 12 hours after operation during a period of hypotension in another patient. As soon as the hypotensive episode due to cardiac arrhythmia was corrected, the paraplegia subsided and the patient remains well.

The results or extent of operation in terms of operating time, organ ischemia time, and blood loss as measured by amount of blood replacement required varied with the type of operation employed. The syphilitic sacciform

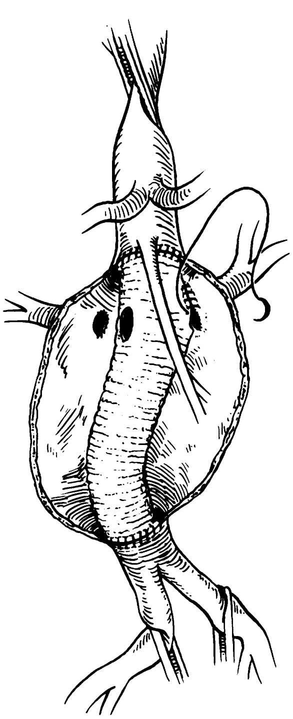


FIG. 8. Diagram showing reconstruction after removal of aneurysm involving origins of renal arteries by direct suture of renal artery orifices to circular opening made in the graft as in Type III operation.

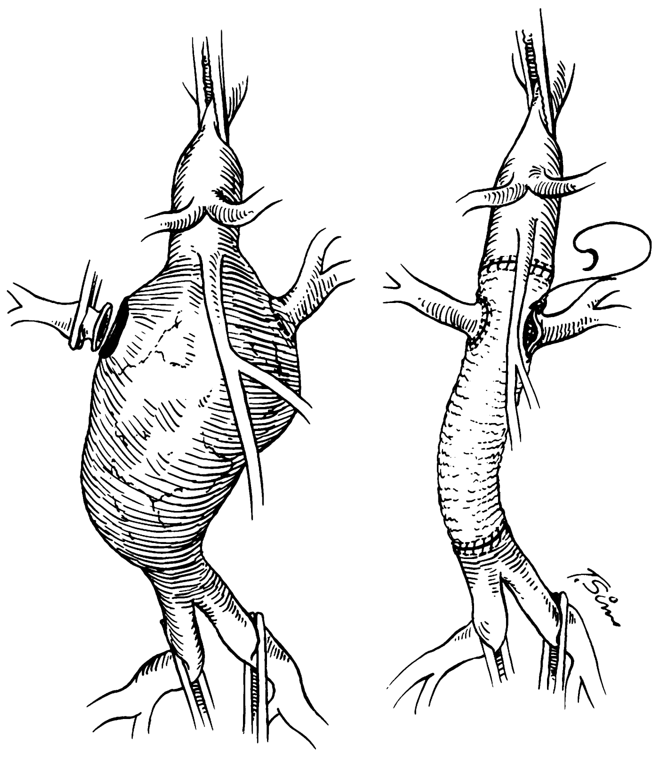
temporary occlusion to these organs ranged from 19 to 60 minutes. The cause of false aneurysm in the patient who died at exploration for rupture 13 years after the original operation was deterioration and fragmentation of silk suture used for the distal aortic anastomosis. The cause of false aneurysm in the other patient who died of massive hemoptysis at home and presumably from false aneurysm rupture probably was from silk suture failure also.

Discussion

The results of treatment in this series of cases are considered similar to those obtained in the treatment of less complicated lesions of the aorta. The obvious reason for this is the fact that simple techniques were adopted in the treatment of these more complicated lesions (those involving renal, superior mesenteric, and celiac arteries) early in this experience. The first four cases in this series were treated with Type I operation. From this small experience, it became obvious that this big operation requiring long time for its extensive dissection, the complicated type of vascular reconstruction, and the associated blood loss could not be tolerated by the older patient or

aneurysms averaged 3 hours operating time and 2500 cc blood replacement for excision and patch graft replacement. Circulation was temporarily interrupted in the abdominal aorta and major visceral branches for 15 and 20 minutes in these two cases. Replacement of abdominal aortic aneurysm involving only the renal arteries required from 1 hour 30 minutes to 2 hours 28 minutes. Blood replacement requirements ranged from 500 to 2500 cc. Interruption of renal artery circulation ranged from 22 to 53 minutes in these cases. The greatest and most significant difference in these factors varied with the type of operation employed in the treatment of patients with fusiform aneurysms involving the aortic segment from which all the major vessels arose. The average operating time and blood replacement requirements for Type I operations were 5 hours 25 minutes and 6250 cc whole blood respectively. Left renal artery ischemia ranged from 19 to 30 minutes and right from 39 to 50 minutes. The average operating time for Type II operations ranged from 2 hours 20 minutes to 4 hours, averaging 2 hours 45 minutes. Visceral organ ischemia time ranged from 20 to 37 minutes and blood replacement requirements averaged 3000 cc. Type III operation required an average of 3 hours 30 minutes and 3000 cc blood. The ischemia time was celiac axis 27 minutes, superior mesenteric artery 37 minutes, right renal artery 49 minutes, and left renal artery 60 minutes.

There were neither transient nor permanent ischemia problems of the gastrointestinal tract, kidneys, and lower extremities in any of these cases, although periods of



A. B.

FIG. 9. Diagram showing reconstruction after removal of aneurysm involving origin of renal arteries. A small circular island of aneurysm from which the renal arteries arise is excised (a) and sutured to circular openings made in the graft (b). All aneurysmal tissue is included in the suture producing direct renal artery anastomosis.

those patients with associated cardiac and respiratory diseases. To minimize these factors contributing to extent of operation, Type II operation was adopted as the preferable form of treatment. Despite the fact that shunts were not employed, the longer periods of temporary organ ischemia were well tolerated. Eliminating the major parts of the dissection required for Type I operation by exposure and reconstruction within the aneurysm and reducing blood loss both by this technique and by inclusion of grafts and arterial reconstruction tremendously reduced the magnitude of operation. Moreover, eliminating the principle of insertion of the aortic graft first around the aneurysm as a shunt to be used subsequently as the permanent graft made it possible to individualize exposure in these cases. For example, Type II and III operations are confined to the abdomen when the aneurysm does not extend above the diaphragm whereas thoraco-abdominal exposure was routinely required when employing Type I operation.

A theoretical disadvantage to Type II operation is the fact that the island of aneurysmal wall containing the origins of the right renal, superior mesenteric, and celiac arteries sutured to the side of the aortic graft also contains a small area of aneurysmal wall between the orifices of those vessels. Theoretically, this weakened area like aneurysmal wall is subject to later rupture. This fortunately has not occurred in this series of 12 cases with followup for 1 to 5 years. Nonetheless, these considerations have led to the application of the Type III operation in two cases during the past year. In view of limited experience, the applicability of this technique is not evident; however, it will be considered the procedure of choice if its application in future cases is as easy and as successful as it has been to date.

Addendum

Since this paper was submitted, 5 additional patients have been treated for aneurysms which involved the celiac, superior mesenteric, and renal arteries by procedures combining techniques described as Type II and III operation. The aneurysm involved both thoracic and abdominal aorta in 4 and was confined to the abdominal aorta in 1 patient. Death occurred from cardiac failure in 1 patient with chronic heart and renal disease in whom operation was performed for rupture of large thoraco-abdominal aortic aneurysm.

References

1. Connolly, J. E.: Discussion: Surgical Considerations in the Treatment of Aneurysms of the Thoraco-Abdominal Aorta. Ann. Surg., **162**:650, 1965.
2. Crawford, E. S., Fenstermacher, J. M., Richardson, M.D. and Sandiford, F.: Reappraisal of Adjuncts to Avoid Ischemia in the Treatment of Thoracic Aortic Aneurysms. Surgery, **67**: 182, 1970.
3. Crawford, E. S. and Rubio, P. A.: Reappraisal of Adjuncts to Avoid Ischemia in the Treatment of Aneurysms of Descending Thoracic Aorta. J. Thorac. Cardiovasc. Surg., **66**:693, 1973.
4. DeBakey, M. E., Crawford, E. S., Garrett, H. E., Beall, A. C., Jr. and Howell, J. F.: Surgical Considerations in the Treatment of Aneurysms of the Thoraco-Abdominal Aorta. Ann. Surg., **162**:650, 1965.

Discussion

President Hardy: I would like to ask whether or not one should use total body heparinization during the period in which the perfusion of the viscera has been temporarily discontinued.

Dr. James R. Jude (Miami): I rise because as I listened to this this paper I thought about the few patients I have had with this extensive problem, and which generally result either in or near a disaster. The blood loss always seemed to be at least 6000 cc for us. If you take just those aneurysms isolated to the descending thoracic aorta and have to replace the entire descending thoracic aorta, which I have had to do a number of times, there always seem to be some, at least, transitory lower extremity weakness. Fortunately, we have never had any complete paraplegia persist.

I'm interested to hear that you have had only one case of paraplegia, because if you do your procedure where you have to replace both the thoracic and abdominal aorta, I would think that this would be even more likely. You did mention, however, that you reanastomosed the lumbar arteries, at least in one case, and this may be important if anatomically feasible.

I'd like to ask two questions: First, how often do you see at least a temporary paresis from your thoracoabdominal aortic resection?

And the second question is about the indications for operating on this type of patient. I see a lot of patints with a lower thoraco-abdominal fusiform aneurysm, beginning in the lower thoracic aorta and extending down to just above the renal arteries, who are quite old; i.e., over 65.

We follow these because I believe the mortality rate there would be horrendous and I tend to think that the results, at least in our hands, are better in following them than if we try to do such a massive procedure.

Dr. E. Stanley Crawford (Closing discussion): Heparin was not used in these cases to avoid the possibility of increasing blood loss.

Paraplegia is likely to occur after operation in approximately 5% of cases with thoraco-abdominal aortic aneurysms. This incidence can be reduced by maintaining normal blood pressure and sparing and reattaching intercostal and lumbar arteries.

I feel that aggressive treatment, i.e., excision and graft replacement, is indicated in these cases. Despite the fact that the majority of the cases in this series were in the older age group and having had rupture, leakage, or pain from expansion and erosion, the majority survived and were restored to good health.